REMARKS

Claims 1-12 remain pending in the application.

Claims 1-12 over Chen in view of Abel

In the Office Action, claims 1-12 were rejected under 35 U.S.C. §103(a) as allegedly being obvious over Chen et al., U.S. Patent No. 5,500,900 ("Chen") in view of Abel, U.S. Patent No. 5,659,619. The Applicant respectfully traverses the rejection.

Claims 1-4 recite, *inter alia,* a plurality of spatial characteristic functions derived from **time domain** head-related transfer functions and adaptively combined with a plurality of Eigen filters.

Chen appears to disclose a free-field-to-eardrum transfer function (FETF) developed by comparing auditory data for points in three-dimensional space for a model ear and auditory data collected for the same listening location with a microphone (Abstract). Each FETF is represented as a weighted sum of frequency-dependent functions obtained from an expansion of a measured FEFT covariance matrix (Chen, Abstract). Spatial transformation characteristic functions (STCF) are applied to transform the weighted frequency-dependent factors to functions of spatial variables for azimuth and elevation (Chen, Abstract). A generalized spline model is fit to each STCF to filter out noise and permit interpolation of the STCF between measured points (Chen, Abstract). A spline model used to generate the STCFs, smooths measurement noise and enables interpolation of the STCFs between measurement directions (Chen, col. 5, lines 18-20). A regularizing parameter within the spline model controls a trade-off between smoothness of a solution and its fidelity to the data (Chen, col. 5, lines 29-31).

The Office Action correctly acknowledges that Chen fails to disclose deriving a plurality of spatial characteristic functions from **time domain** head-related transfer functions (HRTFs) (Office Action, page 3). The Office Action relies on Abel to make up for deficiencies in Chen to allegedly arrive at the claimed invention. The Applicant respectfully disagrees.

Abel appears to disclose a three-dimensional virtual audio display method that generates a set of transfer function parameters in response to a spatial location or direction signal (Abstract). The set of transfer function parameters are selected from or are interpolated among parameters derived by smoothing frequency components of a known transfer function over a bandwidth which is a non-constant function of frequency (Abel, Abstract). Compressed HRTFs are derived by smoothing a convolved frequency response of an input HRTF with a frequency dependent weighting function in the frequency domain (Abel, col. 6, lines 18-22). A time-domain dual of the frequency dependent weighting function may be applied to the HRTF impulse response in the time domain (Abel, col. 6, lines 23-25). A three-dimensional spatial location or position signal is applied to an equalized HRTF parameter table and interpolation function, resulting in a set of equalized HRTF parameters (Abel, col. 9, lines 38-43). An input audio signal is applied to an equalizing filter and an imaging filter whose transfer function is determined by the interpolated equalized HRTF parameters (Abel, col. 9, lines 43-46). The equalizing filter may be located after the imaging filter (Abel, col. 9, lines 47-48).

Abel discloses generating compressed HRTF parameters in response to a spatial location or direction signal. The compressed HRTFs are derived through interpolation, smoothing and equalization. A time domain dual of a frequency dependent weighting function is applied to a HRTF impulse in the time domain (Abel, col. 6, lines 23-25). Smoothing may be implemented as a time-domain window function multiplication (Abel, col. 8, lines 59-60). Although Abel discloses use of HRTFs, Abel fails to disclose or suggest the HRTFs **themselves** are in a **time domain**, as recited by claims 1-4.

Moreover, Abel fails to even mention use of either spatial characteristic functions (SCFs) or Eigen filters, both of which are **terms of art**. Abel fails to disclose deriving SCFs from HRTFs **or** combining SCFs with Eigen filters, much less combining **SCFs** derived from **time domain** HRTFs with a plurality of **Eigen** filters, as recited by claims 1-4.

Neither Chen nor Abel, either alone or in combination, disclose, teach or suggest a plurality of spatial characteristic functions derived from **time**

domain head-related transfer functions **in combination with** combining the spatial characteristic functions with a plurality of Eigen filters, as recited by claims 1-4.

Claims 5-8 recite, inter alia, a plurality of spatial characteristic functions derived from head-related impulse responses and adapted to be respectively combined with a plurality of Eigen filters.

As discussed above, Abel fails to even mention use of either spatial characteristic functions (SCFs) or Eigen filters, both of which are **terms of art**. Abel fails to disclose, teach or suggest deriving SCFs from HRTFs **or** combining SCFs with Eigen filters, much less a plurality of spatial characteristic functions derived from head-related impulse responses **in combination with** combining the plurality of spatial characteristic functions with a plurality of Eigen filters, as recited by claims 5-8.

Neither Chen nor Abel, either alone or in combination, disclose, teach or suggest a plurality of spatial characteristic functions derived from head-related impulse responses and adapted to be respectively combined with a plurality of Eigen filters, as recited by claims 5-8.

Claims 9-12 respectively recite, *inter alia*, constructing a covariance data matrix of a plurality of measured time domain head-related transfer functions and constructing a time domain covariance data matrix of a plurality of measured head-related impulse responses.

Chen appears to disclose choosing Eigen filters as Eigen vectors corresponding to the largest Eigen values of a sample covariance matrix formed from spatial samples of FETF frequency vectors (col. 4, lines 39-43). The Eigen vectors are processed to calculate samples of the STCFs as a function of spatial variables for each direction from which sound has been measured (Chen, col. 5, lines 56-60). A generalized spline model is fit to the STCF samples using a commercial software package (Chen, col. 5, line 66-col. 6, line 1). The spline model filters out noise from each of the sampled STCFs, producing continuous functions of spatial variables (Chen, col. 6, lines 3-5).

Abel discloses a time domain dual of a frequency dependent weighting function is applied to a HRTF impulse in the time domain (Abel, col. 6,

lines 23-25). Smoothing may be implemented as a time-domain window function multiplication (Abel, col. 8, lines 59-60).

Chen teaches use of frequency domain functions. Chen fails to disclose, teach or suggest constructing a covariance data matrix of a plurality of measured time domain head-related transfer functions and constructing a time domain covariance data matrix of a plurality of measured head-related impulse responses, as respectively recited by claims 9-12.

As discussed above, Abel fails to mention or suggest using a **time domain** HRTF. Moreover, Abel fails to even mention a covariance data matrix, much less a covariance data matrix constructed of a plurality of measured time domain head-related transfer functions and constructing a time domain covariance data matrix of a plurality of measured head-related impulse responses, as respectively recited by claims 9-12.

Neither Chen nor Abel, either alone or in combination, disclose, teach or suggest constructing a covariance data matrix of a plurality of measured time domain head-related transfer functions and constructing a time domain covariance data matrix of a plurality of measured head-related impulse responses, as recited by claims 9-12.

A benefit of utilizing time domain HRTFs, versus Chen's use of frequency domain HRTFs is, e.g., that they are simpler to derive since not requiring complex number crunching and are computationally cheaper to implement. Though it is principally correct, generalized spline is an expensive calculation in a real-time sense. The Applicant's invention allows use of a generalized spline model in a low cost real-time implementation. Since linear interpolation is a moderate operation in terms of number of instructions needed, the Applicant's invention practically addresses a real-time implementation issue of producing 3D sound digitally, yet preserves the theoretical advantages of the prior art.

Accordingly, for at least all the above reasons, claims 1-12 are patentable over the prior art of record. It is therefore respectfully requested that the rejection be withdrawn.

Conclusion

All objections and rejections having been addressed, it is respectfully submitted that the subject application is in condition for allowance and a Notice to that effect is earnestly solicited.

Respectfully submitted,

William H. Bollman
Reg. No. 36,457

Manelli Denison & Selter PLLC
2000 M Street, NW
Suite 700
Washington, DC 20036-3307
TEL. (202) 261-1020
FAX. (202) 887-0336

WHB/df